

# NASA TECH BRIEF

## *Langley Research Center*



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### Process for Fabrication of Stabilized Aluminum Phosphate Fibers

A process for stabilizing the high-cristobalite phase of aluminum phosphate has resulted in a unique thermal-shock-resistant ceramic which possesses an ideal property combination of high refractoriness and low thermal expansion. This fiber exceeds the performance of fused silica fibers at high temperatures: It shrinks less, does not devitrify into an unstable cristobalite structure, and is potentially less sensitive to impurities. Aluminum phosphate fibers can potentially be used for high-temperature insulation, fire protection, composites, and refractories.

The salt decomposition method is used to form ceramic fibers and also to synthesize powders which can be subsequently formed into a sintered ceramic body. A viscous solution is made by dissolving aluminum metal in a solution of phosphoric and aluminum chloride. Various other stabilizing compounds are then added to the solution in the form of soluble metallic salts. The solution is filtered and boiled down to a solids content of 38 to 48 percent, depending upon which fiberizing method is to be used.

The syrup can be fiberized by any conventional technique by adjusting the viscosity and surface tension. By concentration of the syrup to 45 to 48 percent solids, it can be drawn into a monofilament. A syrup with 42 to 45 percent solids is suitable for centrifugal spinning which can be done on a simple cotton candy machine. By reducing the solids content to 38 to 42 percent, the syrup can be fiberized by blowing a compressed air jet against a free-falling stream. The spinning and drawing processes produce long, continuous fibers approximately 6 to 8 micrometers in diameter. The blowing process will produce much finer fibers, with diameters from 1 to 3 micrometers. The fibers are then dried, calcined, and stabilized.

Successful stabilization was demonstrated with boron, boron and titanium, silicon and boron, and scandium. Comparisons were made between thermal-expansion data for boron-stabilized aluminum phosphate with unstabilized aluminum phosphate, and other ceramic oxide

fibers. They revealed that the thermal expansion coefficient of the stabilized material, at this stage of development, was approximately one-half that of mullite but still higher than silica.

Stabilized aluminum phosphate can be used in forms other than fibers. Dense bodies of this material could be used where temperatures cycle rapidly to above 1260° C (2300° F). The fact that the crystal structure is cubic also makes fully-dense transparent windows a possibility. This would be useful where large amounts of light energy must be transmitted.

#### Notes:

1. The following documentation may be obtained from:  
National Technical Information Service  
Springfield, Virginia 22151  
Single document price \$4.00  
(or microfiche \$2.25)  
Reference: NASA CR-132331 (N74-10544), Development of an External Ceramic Insulation for the Space Shuttle Orbiter; Part 3 - Development of Stabilized Aluminum Phosphate Fibers
2. Technical questions may be directed to:  
Technology Utilization Officer  
Langley Research Center  
Mail Stop 139-A  
Hampton, Virginia 23665  
Reference: B74-10185

#### Patent status:

NASA has decided not to apply for a patent.

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